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(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-162 25 Stockholm (SE).

(72) Inventor: OLOFSSON, Lars-Anders; Stallbacken 4, S-175 43 Järfälla (SE).

(74) Agent: ERICSSON MICROELECTRONICS AB; Department for Intellectual Property Rights, S-164 81 Kista-Stockholm (SE).

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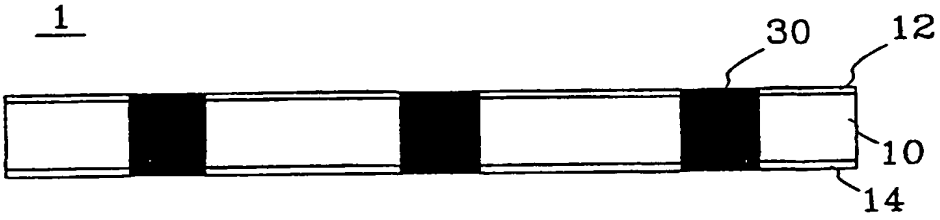
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A PRINTED CIRCUIT BOARD



(57) Abstract: The present invention relates to a method of providing thermal vias in a printed circuit board for conducting heat from surface mounted components through said board and away therefrom. One or more holes are formed in a board material that includes a metal layer on a top side and a bottom side thereof, to form said printed circuit board. Metal plugs are pressed into the holes and affixed therein so as to seal against an inner wall of said holes in said metal layers, by causing the plugs to expand radially in said holes. A conductor pattern that includes electrical connection sites is then provided on the board material, such as to obtain said printed circuit board. The invention also relates to a printed circuit board that includes vias arranged in accordance with the aforesaid method.

WO 01/01738 A1

A PRINTED CIRCUIT BOARD

FIELD OF INVENTION

The present invention relates to a method of arranging thermal vias in a printed circuit board, and to a printed circuit board that includes thermal vias.

BACKGROUND OF THE INVENTION

When surface soldering power components, such as RF-power transistors for instance, it is necessary to improve thermal conduction in the board with the aid of thermal vias. This is because the actual board material, which is often a polymeric material, has very low thermal conductivity, about 0.5 W/m°C, whereas the metallic material has a thermal conductivity of about 400 W/m°C, which is a factor of 800 in this particular case.

The thermal vias are at present formed by drilling a number of holes in the board material, on the surface on which the component body shall be soldered. The inner surfaces of these vias are coated with a thin metallic layer, normally a copper layer in the following stages of board manufacture. It is chiefly this thin copper layer that conducts heat through the board.

One problem with present day thermal vias is that the solder that shall join the component body to the board penetrates down into the holes, therewith draining the soldering location of the solder required to effect the bond, and forms solder droplets on the opposite side of the board relative to the component body. The problem with these solder droplets is that they considerably impair the thermal contact between an underside of the board and a cooler, and it is therefore necessary to remove these droplets in one way or another.

SUMMARY OF THE INVENTION

One object of the present invention is to at least reduce the aforesaid problem.

According to a first aspect of the present invention this object is achieved with a printed circuit board according to Claim 1.

One advantage afforded by the present invention is that the printed circuit boards have a considerably lower thermal resistance from an upper side to a lower side of said boards in comparison with boards that are manufactured in accordance with present day technology.

Another advantage afforded by the present invention is that probing of the vias is simplified when they are fully closed.

Another advantage afforded by the present invention is that power components can be surface mounted at the same time as all other components are surface mounted on the board, which considerably lowers costs in relation to traditional manual mounting processes.

Still another advantage afforded by the present invention is that the cooler or chassi need not fulfil the high requirements of surface flatness, since components, such as RF-power transistors, can be surface soldered directly onto the printed circuit board.

The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of a board for the manufacture of a printed circuit board.

Figure 2 shows from above a board provided with holes and intended for the manufacture of a printed circuit board.

Figure 3 is a side view of an inventive board into which thermal vias have been firmly pressed and which is intended for the manufacture of a printed circuit board.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 is a side view of a board 1 intended for the manufacture of a printed circuit board. The board 1 includes board material 10 on which there has been disposed a metallized top and bottom surface 12 and 14 respectively. The metallized top and bottom sides form basis for the conductor pattern, i.e. the conductor pattern is etched from the electrically conductive top and bottom sides by methods which are well known to the person skilled in this art and which do not therefore need to be described in detail in this document. The board material is some suitable, commercially available material, such as FR4 or BT for instance.

Figure 2 shows from above a board 1 that includes three holes 20. The size and the shape of the holes 20 are adapted to accommodate metallic plugs that are to be pressed into the holes.

Figure 3 is a side view of a printed circuit board 1 in which metallic plugs 30 have been pressed into said holes. The metallic plugs are pressed into the board material and compressed or upset axially, such as to cause the plugs to expand in a direction orthogonally to the longitudinal direction of respective holes 20. Expansion of the plugs 30 causes the plugs to be urged outwards against an inner wall

surface of the metallic layer 12 and 14 on respective top and bottom sides of the board material 10. The plugs form thermal vias in the board 1 and also form a tight surface with the peripheral metallic layers 12 and 14. In order to improve the final result in the subsequent lithographic patterning of a conductor pattern and the following etching process, it may be necessary to smooth down the top and bottom sides of the board, so as to eliminate any differences in heights between the metallic layers 12 and 14 and the plug 30.

The plugs 30 are preferably made of copper. Although the plug-receiving holes 20 in the board will preferably be circular in shape, they may, alternatively, be rectangular, triangular or elliptical in shape. The shape and size of respective plugs 30 are adapted to the shape and size of respective holes 20 in the board. The holes will preferably contain no sharp corners.

Thermal conductivity can be further improved by placing an additional copper layer on the bottom and/or the top side of the board prior to creating said conductor pattern. The presence of such an additional layer will ensure that chemicals do not penetrate into any possible cracks between the plug and the hole, in the following process stages.

Although the board illustrated in the figures is a two-layer board, it will be understood that the present invention can also be applied to single-layer boards or boards that comprise more than two layers. In the case of boards that include more than two layers, the plugs will seal against an inner wall surface of the metallic layer 12 and 14 on respective top and bottom sides of the board material 10 and not against the metallic layer or layers within the board.

It will be understood that the invention is not restricted to the aforedescribed and illustrated exemplifying embodiments

thereof and that modifications can be made within the scope of the following claims.

CLAIMS

1. A method of arranging thermal vias in a printed circuit board for conducting heat from surface mounted components through said board and away therefrom, characterized by providing one or more holes on a top side and a bottom side of at least one board that includes a metallic layer, pressing metal plugs into said holes such as to fix and seal said plugs against an inner wall in said holes in said metal layers on the board by compressing or upsetting the metal plugs, and thereafter providing the board with a conductive pattern that includes electrical connection sites and therewith obtain a printed circuit board.

2. A method according to Claim 1, characterized by providing on said top and/or bottom surface of the board a metallic layer that lies on and adjacent to said metal plugs.

3. A method according to Claim 1 or 2, characterized by providing at least one conductive pattern layer between the metallic layers on the bottom and top sides of the board.

4. A method according to Claim 1 or 2, characterized in that the holes provided in the board are circular in shape.

5. A method according to Claim 1 or 2, characterized in that the holes provided in the board are rectangular in shape.

6. A method according to any one of Claims 1-5, characterized in that the metal plugs are made of copper.

7. A printed circuit board comprising board material (10), a conductor pattern, at least one electrical connection site, and one or more thermal vias for conducting heat from one or more surface mounted components through said board and away

therefrom, characterized in that the board includes one or more holes (20) into which metal plugs (30) are firmly pressed or firmly upset; in that a metal layer is provided around said plugs on a part of a top side and a bottom side of said board material (10), wherewith said metal plugs (30) seal against and are affixed by an inner wall in said metal layer on the top and the bottom side of said board material (10) as a result of expansion of the metal plugs (30) orthogonally to the longitudinal direction of respective holes (20) when compressing or upsetting the plugs therein, such as to form said thermal vias.

8. A printed circuit board according to Claim 7, characterized in that at least one further conductor pattern layer is provided between said top and bottom sides of the board material (10).

9. A printed circuit board according to Claim 7 or 8, characterized in that the holes (20) in the board (10) are circular in shape.

10. A printed circuit board according to Claim 7 or 8, characterized in that the holes (20) in the board (10) are rectangular in shape.

11. A printed circuit board according to any one of Claims 7-10, characterized in that the metal plugs (30) are made of copper.

12. A printed circuit board according to any one of Claims 7-11, characterized in that a metallic layer is provided on top of and adjacent to the plugs on the top side and/or bottom side of the board.

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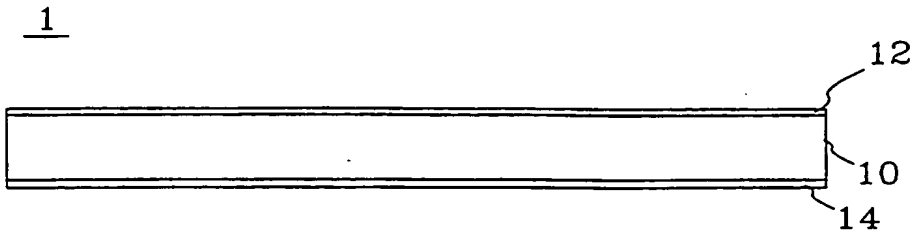

Fig. 1

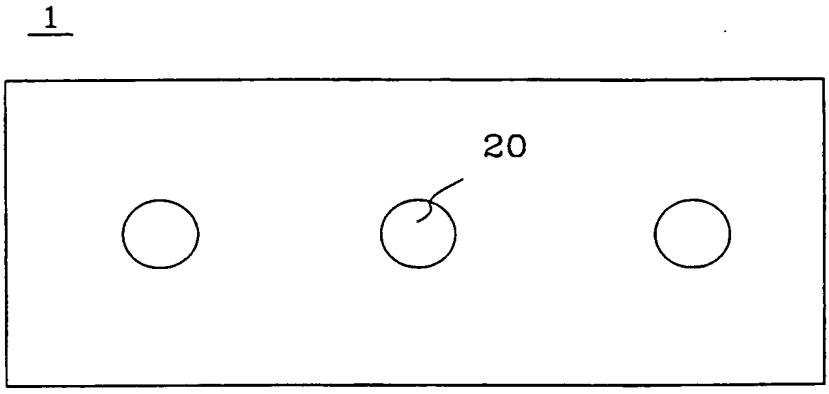

Fig. 2

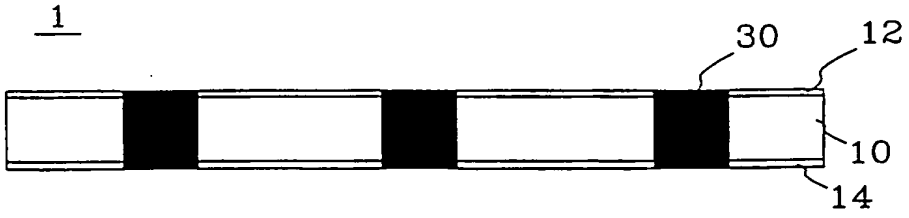

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/01349

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H05K 1/02, H05K 7/20
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 4220966 A1 (SIEMENS AG), 13 January 1994 (13.01.94) --	1-12
X	DE 1953992 A1 (TEMIC TELEFUNKTEN MICROELECTRONIC GMBH ET AL), 13 March 1997 (13.03.97) --	1-12
A	DE 3619226 A1 (VEB KOMBINAT ROBOTRON), 11 June 1987 (11.06.87) --	1-12
A	US 5779134 A (JEFF R. WATSON ET AL), 14 July 1998 (14.07.98) --	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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DE	4220966	A1	13/01/94	NONE		
DE	1953992	A1	13/03/97	NONE		
DE	3619226	A1	11/06/87	DD	243383 A	25/02/87
				DD	243382 A	25/02/87
				DD	243384 A	25/02/87
US	5779134	A	14/07/98	AU	7251896 A	17/04/97
				EP	0852897 A	15/07/98
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				US	5617294 A	01/04/97
				WO	9712504 A	03/04/97